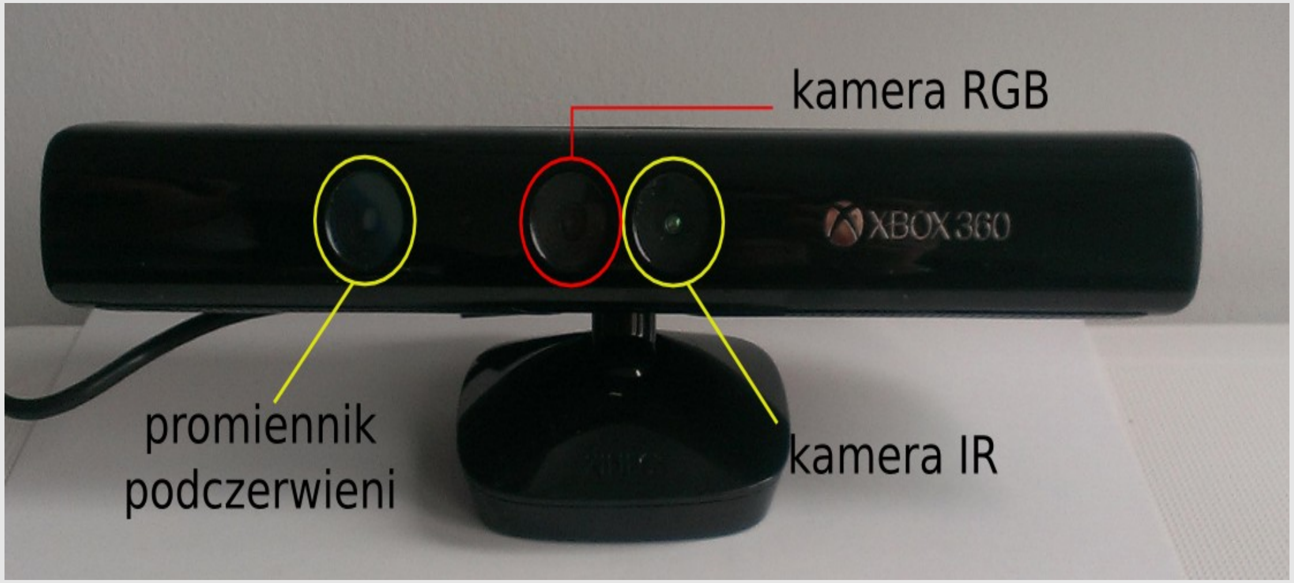
3D camera

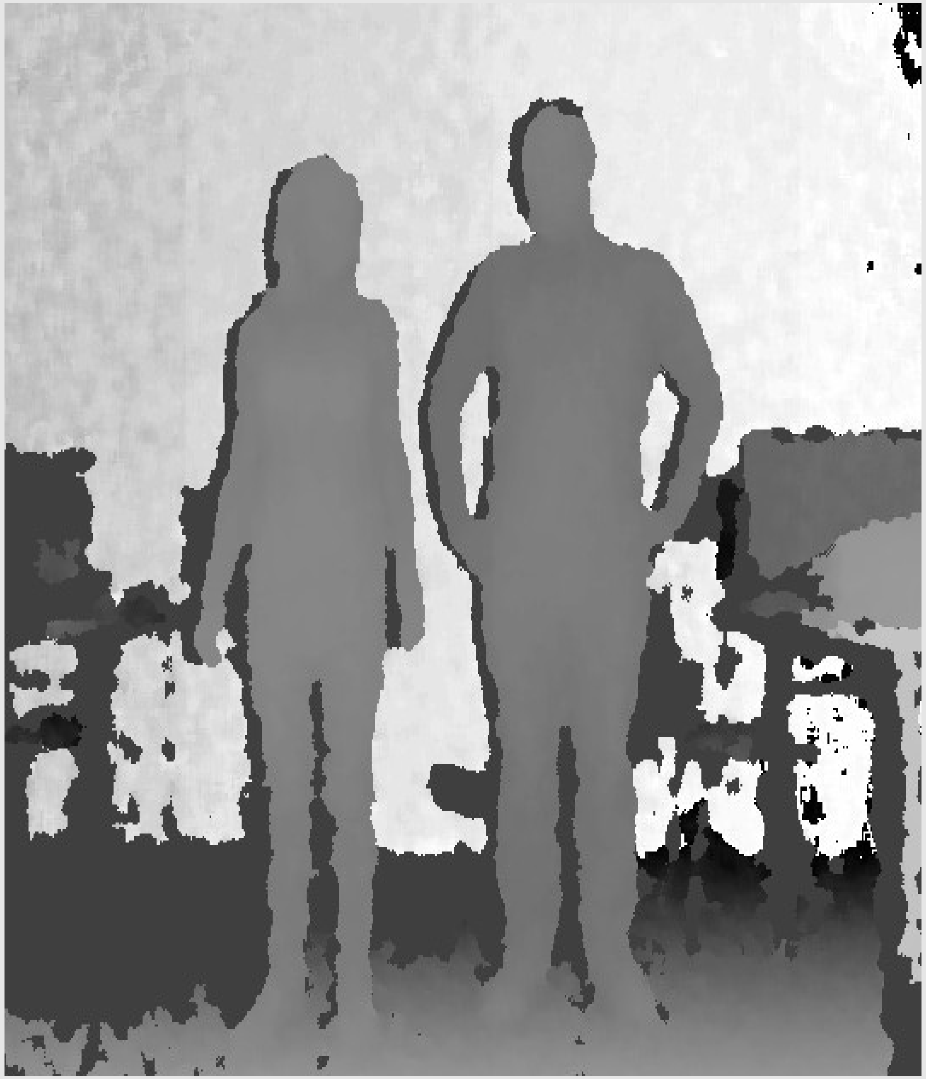
Kinect Xbox 360



Structure of the sensor Kinect Xbox 360:

- Vision camera RGB (CMOS type) with a resolution of 640x480,
- IR camera (CMOS type) – gives the information about the depth (resolution ~300x200),
- 4 directional microphone,
- The infrared radiator

Kinect Xbox 360



Kinect: available libraries

Main libraries that support the sensor:

- OpenNI + NiTE (http://structure.io/openni) (http://openni.ru/openni-sdk/openni-sdk-history-2/index.html),
- Microsoft Kinect SDK (http://www.microsoft.com/en-us/kinectforwindows/),
- OpenKinect (LibFreeNect) (http://openkinect.org/wiki/Main_Page)

	OpenNI	Microsoft SDK
Camera calibration	√	√
Automatic body calibration	×	√
Standing skeleton	√ (15 joints)	√ (20 joints)
Seated skeleton	×	√
Body gesture recognition	√	√
Hand gesture analysis	√	√
Facial tracking	√	√
Scene analyzer	√	√
3-D scanning	√	√
Motor control	√	√

Porównanie bibliotek OpenNI i Microsoft SDK (Han et al., 2013)

Han J. et al., Enhanced Computer Vision with Microsoft Kinect Sensor: A Review, IEEE Transactions on Cybernetics 43 (5), 2013.

Kinect: application

1. Biomechanics and rehabilitation

Personalized games adjusted to the rehabilitation program for patients:

- With neurodegenerative diseases (multiple sclerosis, Parkinson disease, amyotrophic lateral sclerosis, Alzheimer disease)
- neuromuscular disorders
- vascular brain diseases (stroke)
- for elderly

(symptoms: motor and postural deficits, balance disorders, lack of coordination)

VirtualRehab

2. Motion analysis

Brain Scans Manipulation

Interactive Learning

Profesional motion capture systems

Equipment:

Vicon

Vicon, T-Series (źródło: http://www.vicon.com)

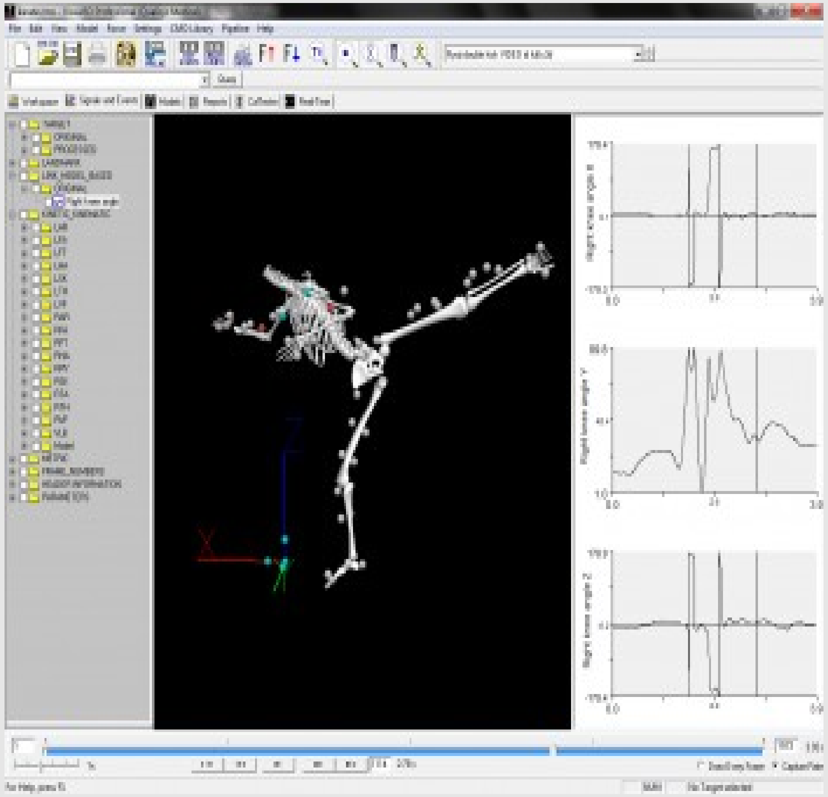
Qualisys

Qualisys,seria Oqus Underwater
(źródło: http://www.qualisys.com/)

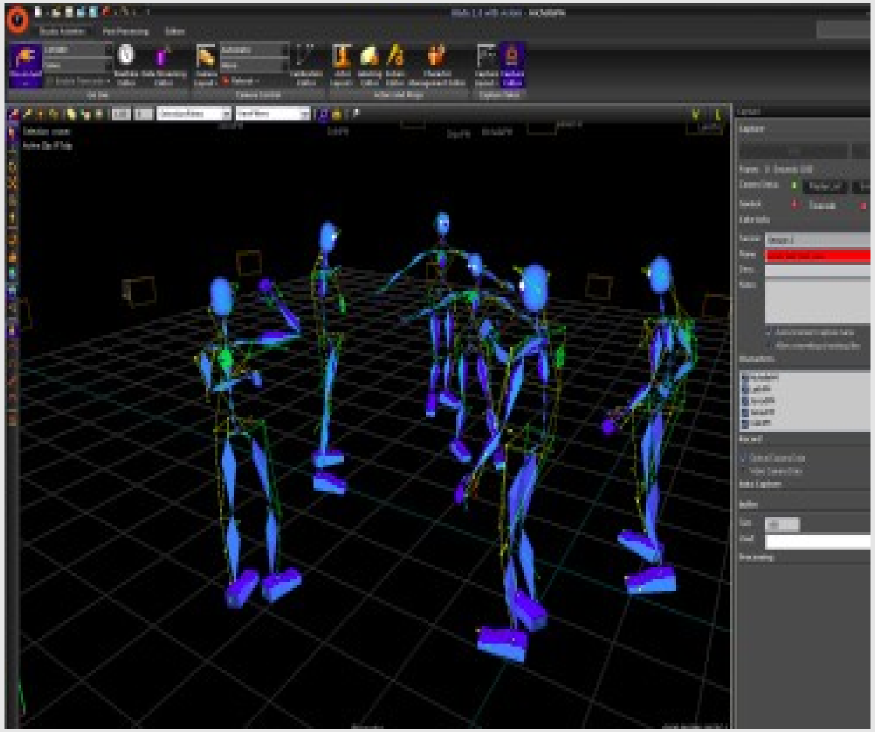
Profesional motion capture systems

Software:

Visual3D (źródło: http://www.qualisys.com/)



Blade (źródło: http://www.vicon.com/Software)

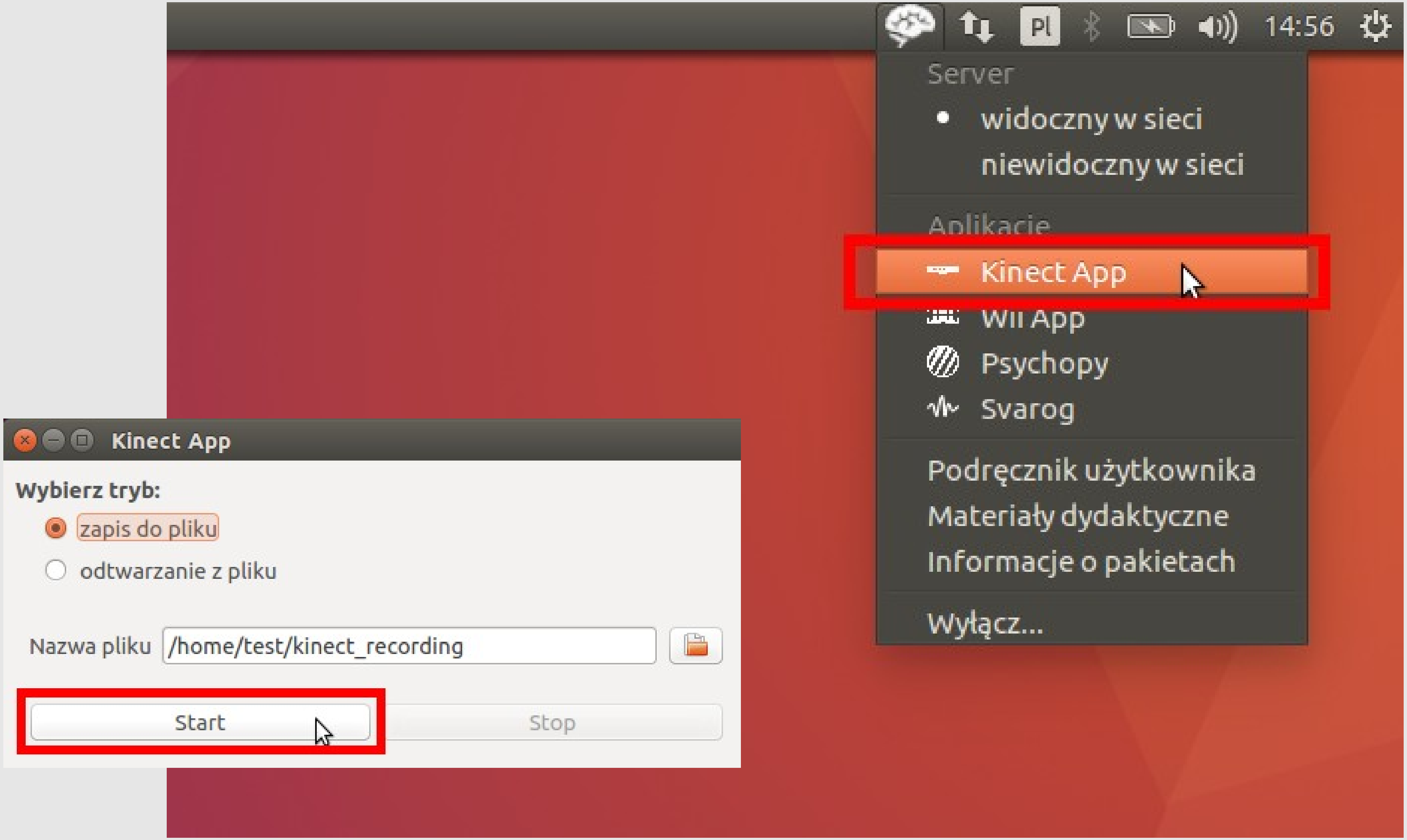


Application:

Computer Games

Kangaroo Study

Kinect: measurement



Kinect: measurement

Task: 'Drop Vertical Jump'

- step onto the platform
- drop from the platform to the ground
- perform a maximal vertical jump

Stone E.E., Butler M., McRuer A., Gray A., Marks J., Skubic M., Evaluation of the Microsoft Kinect for Screening ACL Injury, Conference proceedings: … Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2013:4152-5, 2013

Kinect: Analysis

<u>'Initial Contact'</u>

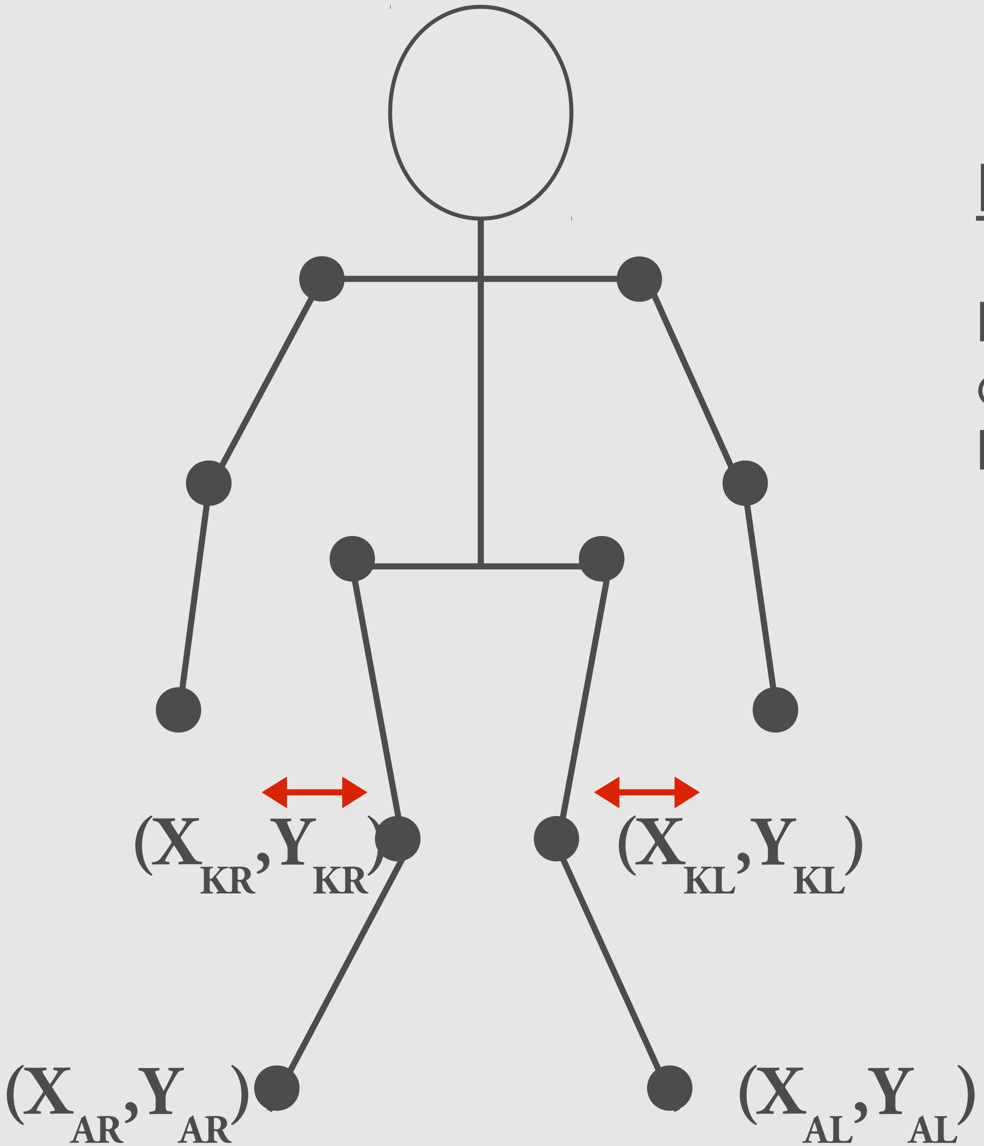
moment when the athlete first makes contact with ground following the drop from the platform

<u>'Peak Flexion'</u>

point of peak flexion following IC and before leaving the ground for the vertical jump

Stone E.E., Butler M., McRuer A., Gray A., Marks J., Skubic M., Evaluation of the Microsoft Kinect for Screening ACL Injury, Conference proceedings: … Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2013:4152-5, 2013

Kinect: Analysis

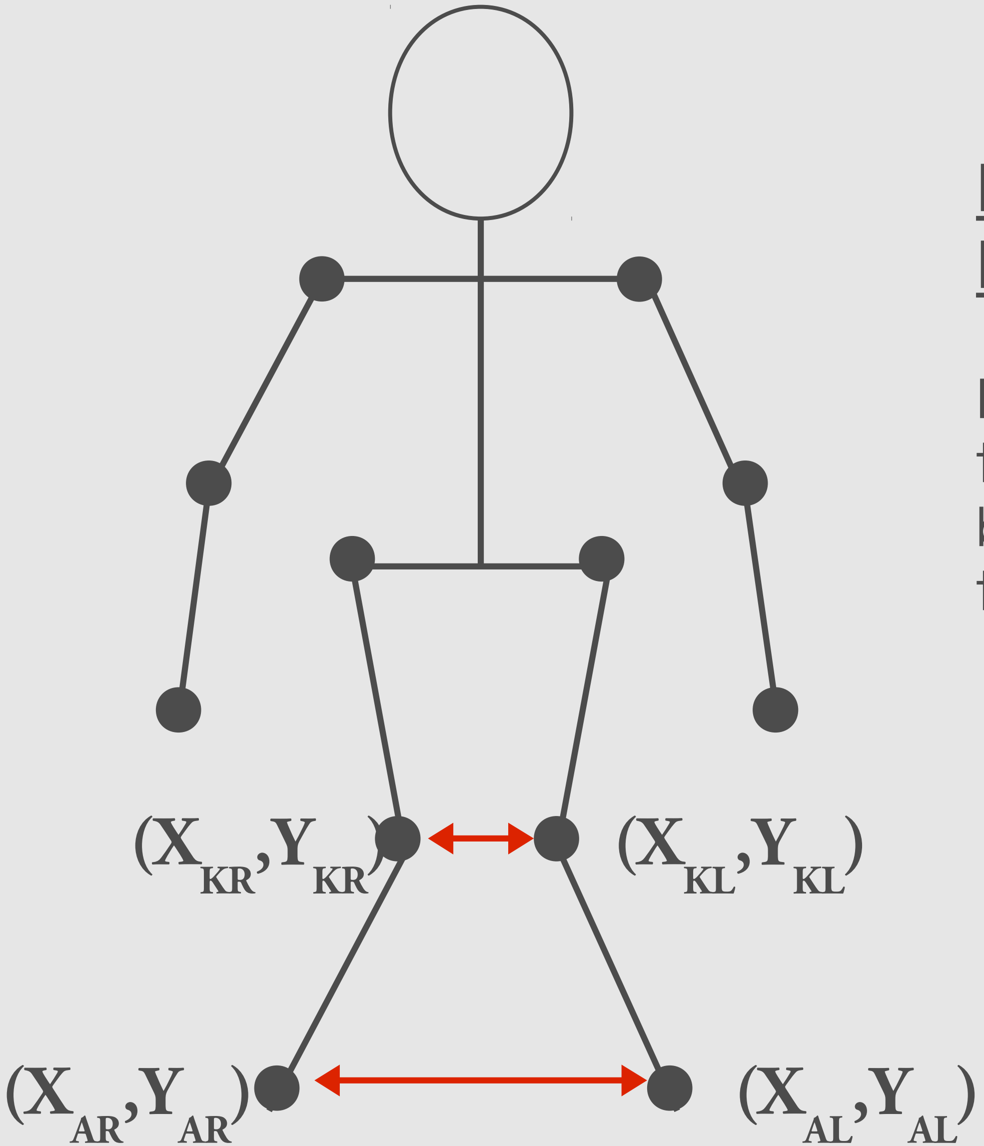


Knee Valgus Motion:

Motion of knee (separately left and right) between time points IC and PF

$$KVM_X = \left| X_{KX}(IC) - X_{KX}(PF) \right|$$

Kinect: Analysis

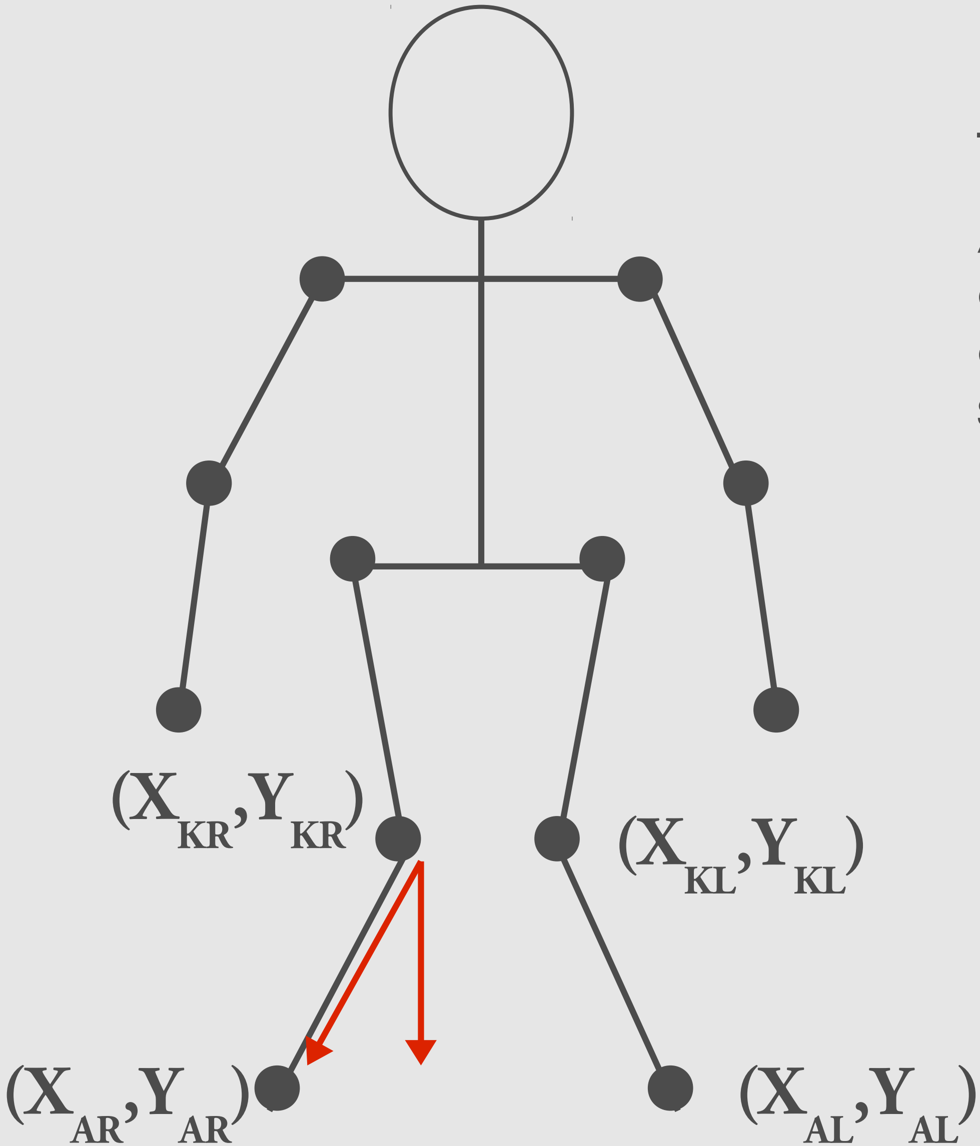


Knee-to-Ankle Separation Ratio:

Ration of the distance between the knees to the distance between the ankles (for the PF time point)

$$KASR = \frac{|X_{KR} - X_{KL}|}{|X_{AR} - X_{AL}|}$$

Kinect: Analysis



Frontal Plane Knee Angle:

Angle between the vertical direction and the vector of knee-ankle direction (separately for left and right side and IC and PF moments)

$$FPKA_X = \arccos\left(\widehat{v}_{KAx} \cdot \widehat{v}_{KGx}\right)$$

$$\widehat{v}_{KAx} = \frac{\langle X_{Ax} - K_{Kx}, Y_{Ax} - Y_{Kx} \rangle}{\left\| \langle X_{Ax} - K_{Kx}, Y_{Ax} - Y_{Kx} \rangle \right\|}$$

$$\widehat{v}_{KGx} = \frac{\langle 0, Y_{Ax} - Y_{Kx} \rangle}{\left\| \langle 0, Y_{Ax} - Y_{Kx} \rangle \right\|}$$

Kinect: Analysis

Data analysis:

Calculate parameters:

- KVM for left and right side
- FPKA for left and right side (for IC and PF)
- KASR for PF moment

Make a plot:

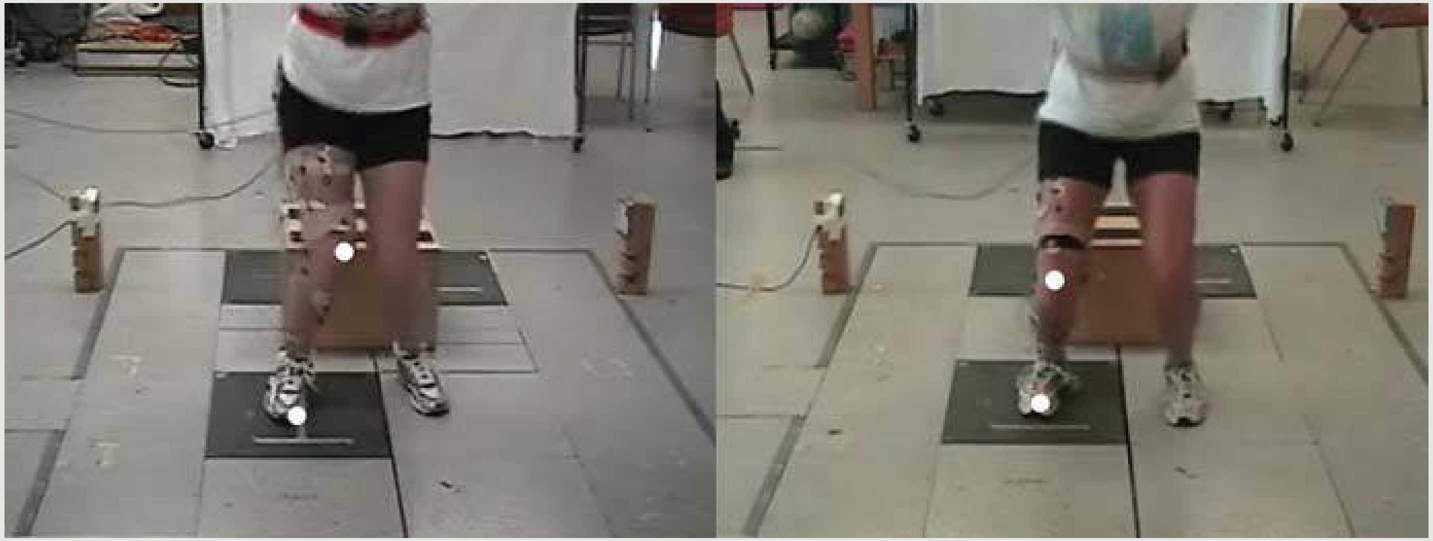
- chnage of joined hips, both knees and ankles position in time

Analysis based on the article:

https://www.eldertech.missouri.edu/wp-content/uploads/2016/07/Evaluation-of-the-Microsoft-Kinect-for-Screening-ACL-Injury.pdf

Kinect: Analysis

High-risk Low-risk



C.L. Ekegren, W.C. Miller, R.G. Celebrini, J.J. Eng, D.L. Macintyre, Reliability and Validity of Observational Risk Screening in Evaluating Dynamic Knee Valgus, Journal of orthopaedic & sports physical therap, Vol.39, No.9, September 2009